

**DATA REPRODUCTION METHOD, DATA RECEIVING TERMINAL AND
DATA RECEIVING METHOD**

BACKGROUND OF THE INVENTION

5 The present invention relates to a reproduction method for AV (audio/video) data that can adapt to changes in the available bandwidth, transmission errors and obstacles or the like, as well as a data receiving terminal and a data receiving method for receiving and reproducing
10 AV data that has been sent from a server.

 In the course of recent advances in video encoding techniques, such as MPEG (Moving Picture Experts Group) -4, AV distribution services on mobile wireless terminals, such as mobile phones, have been initiated, and it is likely
15 that such AV distribution services will become widespread in the near future.

 At present, there are mainly two types of data transmission for AV distribution: download reproduction by HTTP/TCP/IP (Hyper-Text Transfer Protocol/Transmission
20 Control Protocol/Internet Protocol) and streaming reproduction by RTP/UDP/IP (Realtime Transport Protocol/User Datagram Protocol/Internet Protocol). In control sections for streaming reproduction, a protocol called RTSP (Real Time Streaming Protocol) is used for
25 example (see H. Schulzrinne et al., "Real Time Streaming Protocol", RFC 2326, Internet Engineering Taskforce, Apr. 1998).

The download reproduction by HTTP/TCP/IP uses the same data transmission protocol as for browsing web pages on the internet, so that on the one hand it is very easy to realize, but since data are resent when transmission errors occur, it is not well suited for real-time reproduction of AV data for which a real-time approach is desired. By contrast, in streaming reproduction with RTP/UDP/IP, no data are resent in the case of transmission errors, and therefore there is no guarantee that the data are transmitted accurately, but this system is suitable for the real-time reproduction of AV data for which a real-time approach is necessary.

Also, in download reproduction with HTTP/TCP/IP, the data that have been received are ordinarily stored in the memory of the terminal even after reproduction, so that due to memory restrictions, it is not possible to distribute very long-playing content. By contrast, in streaming reproduction with RTP/UDP/IP, the data are ordinarily discarded after reproduction, so that the distributed content is subject to few restrictions regarding time, and the receiving and reproduction of long-playing content is possible.

In streaming reproduction with conventional RTP/UDP/IP, when the transmission path is interrupted, or when the power source of the terminal has inadvertently been disconnected, or when the AV reproduction is interrupted by another application, it was not easy to

resume the reproduction of AV data after restoring the connection. More specifically, if the connection to the server is interrupted during the data reproduction of a certain content, it is not possible to specify the moment
5 when the connection has been interrupted, so that if once the connection to the same content has been reestablished, it was necessary to receive/reproduce the data from the beginning. For this reason, there was the problem that a user could not consume a certain content divided into
10 several parts and at different times or places, which was particularly inconvenient when consuming long-playing content.

Also, mobile wireless devices, such as mobile telephones, have the feature that they can be used while
15 the user moves around, but when the user moves into a region that is not reached by the radio waves (outside the service area), such as a tunnel, there is the risk that the data cannot be received over a long period of time. In this case, the data that have been sent during the region
20 outside the service area are not resent in the case of streaming reproduction with RTP/UDP/IP, so that there is the problem that the data are lost and cannot be consumed.

SUMMARY OF THE INVENTION

25 In view of these problems, it is an object of the present invention to present a data reproduction method, a data receiving terminal and a data receiving method for a

streaming reproduction, in which reproduction can be resumed from an intermediate position of a data stream,

In order to achieve this object with the present invention, time information regarding a time when the reproduction of the data stream is interrupted is held, and the reproduction is resumed from an intermediate position of the data stream based on this time information.

With the present invention, the current reproduction time is held by the data receiving terminal or the sending terminal (server), and if the receiving buffer of the data receiving terminal becomes empty, if the transmission path is interrupted due to an obstacle or the like, if the power source of either of the terminals is disconnected, or if an interrupt is generated by another application (e.g. internet telephone), then the AV reproduction is temporarily stopped. Then, when the transmission path is reopened, or the power source of the devices is turned on again, or if the interrupt by the other application has been resolved, the buffering of the data is started automatically starting from the reproduction time when the buffer has become empty, when the transmission path was interrupted, when the power source of the terminals was cut off, or when the interrupt by the other application was generated, and then those data are reproduced, thus making it possible to realize an AV transmission that is resistant to obstacles. More specifically, a reproduction time t_1 is stored by the data receiving terminal (if necessary,

application name, reproduction content name and user name
etc. can be stored as well), and if the transmission path
is temporarily interrupted, a request is sent by the data
receiving terminal to the sending terminal (server) such
5 that the reproduction is carried out starting at the
reproduction time t_1 when the transmission path is opened
again.

For example, a time stamp of the data when
reproduction was performed is stored in the data receiving
10 terminal, and even if the connection to the server has been
interrupted by the user or due to a worsening of the
receiving situation, it is possible to reproduce starting
with a continuation of the data that were reproduced during
the previous connection.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing an example of the
configuration of a data receiving terminal in accordance
with a first embodiment of the present invention.

20 Fig. 2 illustrates RTP packets that are sent by
RTP/UDP/IP transmission from the sending device in Fig. 1.

Fig. 3 shows an example of the memory structure in
the receiving buffer in Fig. 1.

25 Fig. 4 shows an example of the storage content of the
memory in Fig. 1.

Fig. 5 is a flowchart illustrating an example of the
operation of the memory management unit in Fig. 1.

Fig. 6 is a flowchart illustrating an example of the operation of the connection request creation unit in Fig. 1.

Fig. 7 is a block diagram showing an example of the configuration of a data receiving terminal in accordance with a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the accompanying drawings, the following is a description of a data receiving terminal in accordance with an embodiment of the present invention.

First Embodiment

Fig. 1 is a block diagram showing an example of the configuration of a data receiving terminal in accordance with the first embodiment of the present invention. In Fig. 1, the data receiving terminal 12 according to the present invention receives and reproduces RTP packets that have been sent by RTP/UDP/IP transmission from a sending device (server) 11. The data receiving terminal 12 includes a data receiving unit 101, a receiving buffer 102, a decoding unit 103, a display unit 104, a memory 105, a control unit 106, a user input unit 110 and a message sending/receiving unit 111. The control unit 106 includes a connection address detection unit 107, a memory management unit 108 and a connection request creation unit 109.

Fig. 2 illustrates RTP packets that are sent by RTP/UDP/IP transmission from the sending device 11. As

shown in Fig. 2, RTP packets are made of a header portion and a data portion. The header portion includes time information, such as the reproduction time. The data portions store an MPEG 4 video stream. For example, one
5 frame of the video stream is stored in the data portion of an RTP packet. In MPEG-4, this unit (one frame) is called "VOP" (Video Object Plane). In the following explanations, it is assumed that one VOP data set is sent per RTP packet.

Fig. 3 shows an example of the memory structure of
10 the receiving buffer 102. The data receiving unit 101 receives RTP packets that have been sent from the server, calculates the VOP size, and stores the time stamps indicating the reproduction order of the received VOP data as well as the VOP data itself together with the calculated
15 VOP size in the receiving buffer 102. As shown in Fig. 3, the receiving buffer 102 stores the time stamp 201, the VOP size 202 and the VOP data 203 together as a group. The decoding unit 103 decodes the VOP data stored in the receiving buffer 102 following the time stamps associated
20 with the VOP data, and outputs the decoded VOP data to the display unit 104. If the decoded data is I-VOP (intra-coded VOP), the time stamp of this I-VOP is outputted to the memory management unit 108. The display unit 104 displays the inputted data on the display screen.

25 Fig. 4 shows an example of the storage content in the memory 105. As shown in Fig. 4, the memory 105 stores a plurality of entries grouping together an active flag

indicating the content currently being received, a reproduction termination flag indicating the content that has been reproduced to the end, a connection address indicating the address of the sending device to which the data receiving terminal 12 is connected, a time stamp indicating the position at which the reproduction of the content shown at the connection address is terminated, and the access time indicating the time when the content was accessed. In this embodiment, the active flag is "1" for content that is currently being received, and "0" otherwise. The reproduction termination flag is "1" for content that has been reproduced to the end, and "0" otherwise.

The control unit 106, which controls the entire data receiving terminal 12, manages the memory 105 and requests connection to the server. To be more specific, the connection address detection unit 107 detects whether an entry regarding the connection address that has been outputted from the user input unit 110 is registered in the memory 105. If an entry regarding the connection address is registered, and if there is a request for detection of the time stamp of this entry from the connection request creation unit 109, it detects the time stamp of this entry. The memory management unit 108 manages the memory 105, and when a new entry is created, and a time stamp is outputted from the decoding unit 103, the memory management unit 108 replaces the time stamp in the memory 105 corresponding to the connected device from which data are currently being

received with the time stamp outputted from the decoding unit 103. The connection request creation unit 109 creates a request for connection to a server, based on a user command that is entered into the user input unit 110, and
5 the information stored in the memory 105.

The user input unit 110 is for example a button or a touch panel, and analyzes an external input such as a selection or pushing down by the user, and outputs the result of this analysis to the control unit 106. The
10 message sending/receiving unit 111 sends the connection request that has been created with the connection request creation unit 109 to the server, and processes the response from the server.

The following is a more specific explanation of the
15 operation of the data receiving terminal 12 according to the present invention. When the user inputs a connection address of desired content into the user input unit 110, or when the user selects a region on which a link is placed that leads to video data from a contents scene displayed by
20 the display unit 104, the connection address is outputted from the user input unit 110 to the connection address detection unit 107. When the connection address is output from the user input unit 110, the connection address detection unit 107 searches whether an entry for the
25 connection address outputted from the user input unit 110 is registered in the memory 105, and outputs the detection result to the memory management unit 108 and the connection

request creation unit 109.

Fig. 5 is a flowchart illustrating an example of the operation of the memory management unit 108 when it has received the detection result from the connection address detection unit 107. The memory management unit 108 receives the detection result from the connection address detection unit 107 and performs the following operation: First, the memory management unit 108 receives the detection result from the connection address detection unit 107 in Step S101, and if an entry for the connection address is registered, the procedure advances to Step S102, whereas if no entry for the connection address is registered, the procedure advances to Step S103. If an entry for the connection address is registered, the memory management unit 108 sets the active flag of the entry registered in the memory 105 to "1" (Step S102). On the other hand, if no entry for the connection address is registered, the memory management unit 108 searches at Step S103 whether there is an empty region in the memory 105, and if there is an empty region in the memory, the procedure advances to Step S104, whereas if there is no empty region in the memory, the procedure advances to Step S105. If there is an empty region in the memory, a new entry is created in this empty region (Step S104). The creation of this new entry by the memory management unit 108 is performed by setting the connection address to the connection address specified by the user input unit 110,

and setting the active flag to "1", the reproduction termination flag to "0", and the time stamp to "0". On the other hand, if there is no empty region in the memory, the memory management unit 108 searches at Step S105 whether
5 there is an entry in the memory 105 whose reproduction termination flag is "1". If there is an entry whose reproduction termination flag is "1", then the procedure advances to Step S106, and if there is no entry whose reproduction termination flag is "1", then the procedure
10 advances to Step S107. If there is an entry whose reproduction termination flag is "1", then the entry whose reproduction termination flag is "1" is overwritten with the new entry (Step S106). If there are a plurality of entries whose reproduction termination flag is "1", then
15 the entry with the oldest access time is selected, and this selected entry is overwritten with the new entry. If, on the other hand, there is no entry whose reproduction termination flag is "1", then the registered entry with the oldest access time is selected, and this selected entry is
20 overwritten with the new entry (Step S107).

Fig. 6 is a flowchart illustrating an example of the operation of the connection request creation unit 109, when it has received the detection result from the connection address detection unit 107. The connection request
25 creation unit 109 receives the detection result from the connection address detection unit 107, and performs the following operation: First, the connection request

creation unit 109 receives the detection result from the connection address detection unit 107 in Step S201, and if an entry for the connection address is registered, the procedure advances to Step S202, whereas if no entry for the connection address is registered, the procedure advances to Step S203. If an entry for the connection address is registered, the connection request creation unit 109 looks up the reproduction termination flag of this entry, and detects whether the reproduction termination flag is "0" (Step S202). If the reproduction termination flag is "0", then the procedure advances to Step S203, and if the reproduction termination flag is not "0", then the procedure advances to Step S205. If the reproduction termination flag is "0", then the previous reproduction has been terminated before it was finished, so that the connection request creation unit 109 outputs to the display unit 104 a signal indicating that a message is to be displayed requesting to decide whether to receive starting with a continuation of the previous reproduction, and this message is then displayed (Step S203). Then, if a selection signal selecting that the data should be received starting with a continuation of the previous reproduction is outputted from the user input unit 110, the connection request creation unit 109 detects the time stamp of the corresponding entry via the connection address detection unit 107, the receiving of the data should be requested starting with a continuation of the previous reproduction

of the contents shown by the connection address, a connection request is created with a receiving start position that is shown by the time stamp, and this connection request is outputted to the sending/receiving unit 111 (Step S204). On the other hand, if a selection signal selecting that the data is not to be received starting with a continuation of the previous reproduction is outputted from the user input unit 110, or if no entry for the connection address is registered, or if the reproduction termination flag of the entry for the registered connection address is not "0", then the data should be received starting with the beginning of the content shown by the connection address, and the connection request creation unit 109 creates a connection request not indicating a reception start position, which is outputted to the message sending/receiving unit 111 (Step S205).

Now, when the message sending/receiving unit 111 has received the connection request from the connection request creation unit 109, it sends the connection request created by the connection request creation unit 109 as an RTSP SETUP message to the server. Then, when it has received an OK response from the server, it sends a PLAY message to the server. Moreover, when the message sending/receiving unit 111 receives an OK response regarding the PLAY message from the server, it opens the data receiving unit 101, so that data can be received. On the other hand, if the message sending/receiving unit 111 cannot receive an OK response

from the server, it is judged that connection is impossible, and the user is notified of the fact that connection was not possible by display on the display unit 104. The data receiving unit 101 opened by the message sending/receiving unit 111 receives a series of RTP packet data sent by the server, and stores the time stamp, data size and VOP data for each VOP in the receiving buffer 102.

The decoding unit 103 retrieves the data successively from the receiving buffer 102 in accordance with the time stamps of the VOPs stored in the receiving buffer 102, decodes the data, and outputs the decoded data to the display unit 104. At the same time, the decoding unit 103 determines during the decoding of the data whether the data that are being decoded are I-VOPs. If the decoded data are I-VOPs, then the time stamp of the corresponding I-VOP is outputted to the memory management unit 108. On the other hand, if the decoded data are not I-VOPs, then the time stamp of the corresponding I-VOP is not outputted to the memory management unit 108. When the memory management unit 108 receives the output of the time stamp from the decoding unit 103, it detects the entry of the memory 105 for which the active flag is "1", indicating the connection address that is currently being received, and replaces the time stamp of the entry with the time stamp outputted from the decoding unit 103. Also, the data decoded by the decoding unit 103 are displayed by the display unit 104, and thus presented to the user.

When the content being received has been reproduced to the end, a signal indicating the fact that the reproduction of the content has terminated is sent from the decoding unit 103 to the memory management unit 108, and
5 the memory management unit 108 detects the entry in the memory 105 for which the active flag is "1", sets the reproduction termination flag of that entry to "1", and resets the active flag to "0".

The following is an explanation of the operation of
10 the data receiving terminal 12 for the case that the user performs on the user input unit 110 an operation that interrupts the connection to the server while the data are being reproduced. When the user for example presses a button for interrupting the reception/reproduction of data
15 on the user input unit 110, a signal interrupting the reception/reproduction of data is outputted from the user input unit 110 to the control unit 106. The control unit 106, which receives from the user input unit 110 the signal indicating the fact that the sending/receiving of data is
20 interrupted, performs a process halting the reception/reproduction of the data. That is to say, the control unit 106 closes the data receiving unit 101, resets the receiving buffer 102 and the decoding unit 103, and resets all active flags of the entries in the memory 105 to
25 "0". It should be noted that in this situation, the time stamp of the I-VOP that has been decoded/reproduced last for the data that were previously reproduced, is recorded

by the memory management unit 108. Also, the control unit 106 commands the message sending/receiving unit 111 to halt the sending of data, and the message sending/receiving unit 111 sends an RTSP TEARDOWN message to the server. This
5 halts the sending of data from the server.

Thus, with the data receiving terminal 12 according to this embodiment, the memory management unit 108 stores the time stamp of data that have been decoded/reproduced last at the time of data reproduction in the memory 105, so
10 that even if the user terminates the reception at an intermediate position, the data can be received starting with the continuation of the previous reproduction when that content is reproduced again, and the user can change the time and place of long-playing content as convenient,
15 or consume the content partitioned into several parts.

Also, because of the entries stored in the memory 105, the entry indicating the content of the current connection is marked with an active flag, the memory management unit 108 can detect the entry whose time stamp is to be updated
20 by looking at the active flag when the time stamp is being updated, so that it is possible to improve the speed of the process of updating the time stamp, which also leads to a reduction of the consumed power. Furthermore, because of the entries stored in the memory 105, the entries
25 indicating the content that has been reproduced to the end are marked with a reproduction termination flag, the connection request creation unit 109 can detect the entries

whose reproduction has been terminated to the end by looking at the reproduction termination flags at the time of creating a connection request, so that the speed of creating a connection request can be improved, which also
5 leads to a reduction of the consumed power.

Furthermore, if the decoding unit 103 has decoded intra-coded data (I-VOP), the time stamp of those data is outputted to the memory management unit 108, so that the number of times that the time stamp is updated by the
10 memory management unit 108 can be reduced, which also leads to a reduction of the consumed power, and if the data are received starting with the continuation of the previously reproduced data, then it is possible to resume the receiving starting with the intra-coded data.

It should be noted that the connection request creation unit 109 of the data receiving terminal 12 of the present embodiment has been explained for the case that a message is displayed asking whether the reproduction should be performed starting with the continuation of the previous
15 reproduction, and the user determines whether the reproduction is continued from an intermediate position, but it is also possible that if an entry for a connection address is registered, and if the reproduction termination flag is "0", then the connection request is created
20 automatically such that the content data are received starting with the continuation of the previous reproduction.
25

Second Embodiment

Fig. 7 is a block diagram showing an example of the configuration of a data receiving terminal in accordance with a second embodiment of the present invention. In Fig. 7, the data receiving terminal 22 in accordance with the present invention receives and reproduces RTP packets that have been sent by RTP/UDP/IP transmission from a sending device (server) 21. The sending device 21 is provided with a receiving situation analysis unit 201. Also, the data receiving terminal 22 includes a data receiving unit 101, a receiving buffer 102, a decoding unit 103, a display unit 104, a memory 105, a control unit 106, a user input unit 110, a message sending/receiving unit 111 and a receiving situation reporting unit 202. The control unit 106 includes a connection address detection unit 107, a memory management unit 108 and a connection request creation unit 109.

The data receiving terminal 22 according to the second embodiment differs from the data receiving terminal 12 as explained in the first embodiment in that it is further provided with a receiving situation reporting unit 202 for reporting the connection situation with the sending device 21. The structural elements that are the same as in the data receiving terminal 12 according to the first embodiment are marked with the same numerals, and their further explanation has been omitted.

The receiving situation reporting unit 202 of the

data receiving terminal 22 operates during connection to the sending device 21, and regularly sends a reception report to a receiving situation analysis unit 201 of the sending device 21 indicating that the data have been received, and receives a sending report from the receiving situation analysis unit 201 of the sending device 21 indicating that the data have been sent, and if the sending report sent from the sending device 21 is not received at a predetermined time, it is judged that the data receiving terminal 22 has entered a region that is not reached by the radio waves (outside the service area), and this fact is outputted to the control unit 106. In response, the control unit 106 closes the data receiving unit 101, resets the receiving buffer 102 and the decoding unit 103, and resets all active flags of entries in the memory 105 to "0", and displays the fact that the connection has been interrupted on the display unit 104. It should be noted that at this time, the memory management unit 108 stores in the memory 105 the time stamp of the I-VOP that was decoded/reproduced last when reproducing the previous data.

On the other hand, also the receiving situation analysis unit 201 of the sending device 21 operates similarly when connected to the data receiving terminal 22 and regularly receives the reception report that is sent from the receiving situation reporting unit 202 of the data receiving terminal 22, and sends out the sending report, and if the reception report sent from the data receiving

terminal 22 is not received at a predetermined time, it is judged that the data receiving terminal 22 has entered a region that is not reached by the radio waves (outside the service area), such as a tunnel, and the session is interrupted, which means that the sending device 21 stops to send RTP data.

Thus, with the sending device (server) 21 and the data receiving terminal 22 of this embodiment, communication reports indicating whether connection is established are regularly exchanged between the sending device 21 and the data receiving terminal 22, so that both can detect when the data receiving terminal 22 has entered a region that is outside the service area, such a tunnel, and the further session can be interrupted, thus achieving that no unnecessary data are sent, communication costs are reduced, and bandwidth is used advantageously. Also, because the memory 105 stores the time stamp of the I-VOP that has been displayed last, the reproduction can be resumed from the point where the connection had been interrupted, and it is not necessary to go again from the beginning through the entire content for which the connection was interrupted, and the content can be consumed efficiently.

It should be noted that this embodiment has been explained for the case that if the receiving situation reporting unit 202 does not receive within a predetermined time the sending report sent by the sending device 21, it

is judged that the data receiving terminal 22 has entered a region outside the service area, but it is also possible that the receiving situation reporting unit 202 monitors the receiving situation of the RTP packets of the data receiving unit 101, and if the data receiving unit 101 does not receive RTP packets within a predetermined period of time, it is judged that the data receiving terminal 22 has entered a region outside the service area.

Furthermore, if it is judged by the receiving situation analysis unit 201 of the sending device 21 that the data receiving terminal 22 has entered a region outside the service area, it is also possible to store the time stamp of the I-VOP at that time in the sending device 21. Also in this case, it is possible to resume the reproduction from the position where the connection was interrupted. However, since in this case it has to be estimated to which point the data receiving terminal 22 was actually able to receive the data, the present embodiment is superior with regard to reliability.

Now, the data receiving terminals 12 and 22 according to these embodiments have been explained for the case that the time stamp of the content that is currently being received, which is stored in the memory 105, is updated when the decoding unit decodes I-VOP data, but it is also possible to update the time stamp of the content that is currently being received, which is stored in the memory 105, whenever the decoding unit 103 decodes data, regardless of

the type of data, or to update the time stamp when a predetermined period of time has passed. Furthermore, there is no limitation to time stamps affecting the order of the decoding, that is DTS (decoding time stamps), and it is also possible to use so-called CTS (composition time stamps) and PTS (presentation time stamps).

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The embodiments disclosed in this application are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are intended to be embraced therein.